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Why, when, what and how to spray

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Why, When, What and How to Spray.

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Contents.—Bulletin 43.

Introduction.

Competition in horticultural products is each year sharper, and he who would succeed must keep abreast of the times; he must be able to avail himself of the latest and best information upon the subject; with a view of placing this knowledge in the hands of the fruit growers of our State, this publication has been prepared.

The writer of this Bulletin claims no originality in any of the treatments here recommended. The demand for information upon the subject of sprays and their application makes it necessary that such a publication be offered at this time.

The thanks of the author are given to W. & B. Douglas, Middletown, Connecticut, for Figs. 1, 2, 3, 4, ; to F. E. Myers & Bro., Ashland, Ohio, for Fig. 5 ; and to the McGowan Spray Co., Ithaca, N. Y., for Fig. 6.

The remedies given are selected because they have been repeatedly verified by the writer and by others engaged in practical as well as experimental horticulture. The form of spraying outfit described on pages 238 and 239, first published by the writer in Bulletin 35 of the South Dakota Experiment Station, is especially recommended for use in fruit plantations upon hillsides where tanks mounted upon wheels would be liable to upset.

Why Spray ?

It is claimed that fruits formerly needed none of the doctoring that seems to be necessary now-a-days, yet no one contends that wormy apples are of recent origin; apple scab, too, has been marring the beauty of these fruits for many years.

While these enemies have existed for years, remedies for them are comparatively recent. As long as there were no means of preventing their ravages, the fruit grower was compelled to divide his profits with them; but now that cheap and efficient remedies are at our command, why should we longer have the profits reduced? Spray, then, and increase the income from the fruit plantation.

Besides the increase in the quantity of a crop as a result of the use of the spray, the quality of the product is also enhanced. Even if the quantity were not materially increased, more of it will go in as number *one*, and consequently a greater return will be realized.

A third and important consideration to be kept in mind when spraying is the degree to which future depredations are being reduced. Each insect killed might, if left to live, produce many hundred descendents in the course of the season. The rate of increase of some of these destructive insects is almost beyond comprehension.

By preventing the growth and development of this myriad of hungry insects the plant is relieved of a heavy draught upon its vital powers. The energy which would have been used up in maintaining itself against these enemies can be used to extend its own organism and to prepare itself more perfectly to carry a probable crop of fruit.

When to Spray.

To know the best time to apply an insecticide or a fungicide is fully as important as to know the proper time for setting buds or grafts. Every injurious insect and every parasitic disease present some vulnerable place in its life history—some time when it can be most easily exterminated. An insect may be so well fortified that it can only be successfully treated during a very short period. In the case of the Pear Tree Psylla this is the actual condition presented, and unless the work be quickly and thoroughly attended to during the brief time of the immature stage of the insect, the whole work may go for naught. This case is dwelt upon at this time for the purpose of impressing the necessity of following strictly the plans outlined. Disregard for these simple yet important direc-

tions will end in adverse criticism of the methods and means; as well as loss of the time and money expended.

Spray this year, do not delay the operation longer. Every year lost gives just so much more chance for the increase of dangerous insects and diseases; allows them a greater opportunity for reducing the vitality of the plants and consequent shortening of their lives.

Apple trees are shorter lived than they used to be because we ask more in return from them, and expect them to do increased work without a corresponding return in care and food.

To keep up with and prevent loss from these every busy enemies requires a corresponding watchfulness and vigilance on our part.

The inexperienced should not hesitate because he has no experience. Carefully inform yourself, then go ahead!

What to Spray.

In general, all fruit bearing plants, and such vegetables as are troubled with biting or sucking insects or parasitic fungi, should be sprayed.

Injurious insects may be placed in two categories; such as obtain their nourishment from plants by eating their foliage; these for convenience we will denominate biting insects; a second class which by means of a tube-like snout suck their nourishment from the juices of the plant may be termed sucking insects. Insects of the first class, blighting insects, may be treated successfully with the poisonous insecticides, *i. e.*, those that upon being taken into the digestion causes death from poisoning. The sucking insects can not be treated in this way, as it is impossible to get the poisons mixed with their food and thus into the digestive organs of the insect; this class, then, must be attacked from without, *i. e.*, something must be used of such a nature that when it comes in contact with the body of the insect will cause its death. This will, at first thought, seem a somewhat dangerous undertaking. The insecticide must be sufficient to destroy the insect without injury to the host plant. The difficulty in this case is overcome by the fact that insects breathe through pores that open to the outside on the rings or segments of their body. Any material therefore, of a sticky or gummy nature, that after coming in contact with the body of the insect will make a coating through which air does not readily pass, may be effectively used for the destruction of sucking insects. The main difficulty arises from the nature of the necessary material. The expensive oils are excluded because of their cost, and the cheaper oils may be injurious to the plant. Kerosene has become the *one* agent for general use in such insecticides, and its injurious character has been overcome by the use of soap in combination with it, thus making an emulsion.

Fungi.—This class of enemies belong to a low order of plants, which, like a leech, derive their sustenance by robbing others of the food they have prepared for themselves. Fungi are treated by

remedies denominated fungicides. These are of varying form as liquids or powders, depending upon the nature of the disease.

In all cases, the use of either insecticide or fungicide should be preventive rather than remedial.

The numbers used at the left hand side of the page in each of the following descriptions has reference to the number of the spraying, *i. e.*, under apples, 1, 2, 3, 4, 5, signifies that there are five treatments recommended; the first of which is numbered *one*, the second *two*, and so on for each and every treatment necessary for each class of fruits.

APPLE.

(*Tent Caterpillar, Canker Worm, Codling Moth, Bud Moth, Scab.*)

The numbers used in the recommendation of treatments for the various fruits and vegetables have reference to the formulas for preparing these remedies given on pages 243, 244 and 245 of this bulletin.

1. Spray before the buds open with copper sulphate solution, No. 17.
2. After the blossoms have formed, *never while in bloom*, spray with Paris green and Bordeaux Mixture, No. 20.
3. Within ten days from the time of the falling of the blossoms, spray again with Paris green and Bordeaux Mixture, No. 20.
4. Make a fourth application with Bordeaux Mixture and Paris Green, No. 9, ten to twelve days after the third spraying.
5. About ten to twelve days later make a fifth application, this lime using only the Bordeaux Mixture, No. 13, or a weak copper sulphate solution, No. 18.

BEAN.

(*Anthracnose.*)

1. The first spraying should be made with Bordeaux Mixture, No. 13, and while the plants are in first bloom.
2. A second spraying with the same preparation should be made ten days later.
3. Ten to fifteen days repeat the spraying, this time with copper sulphate solution, No. 19.

CABBAGE.

(*Aphids, Worms.*)

1. When worms first appear spray with kerosene emulsion, No. 1, or Paris green, No. 9; if aphids are present use kerosene emulsion.
2. Repeat at intervals of five to seven days until rid of the pests.
3. Do not use Paris green after plants have headed. Saltpetre, one teaspoonful to a gallon of water, should take the place of the Paris green. As a substitute for either, Pyrethrum, No. 4, may be used, dusting it upon and about the plants.

CARNATION.

(*Rust and Other Diseases.*)

1. Dip the plants in Bordeaux Mixture, No. 13, at the time of removing from field to house.
2. Later, six to ten days, spray with Bordeaux Mixture or Ammonical Carbonate, No. 12, of copper.
3. Repeat at intervals of from seven to ten days until blossoms appear.
4. While in bloom spray once a week with a dilute copper sulphate solution, No. 18.

CHERRY.

(*Rot, Aphids, Curculio.*)

1. Before buds open, spray with copper sulphate solution, No. 17, for prevention of rot and mildew; for lice, use kerosene emulsion, No. 1 or 2.
2. When fruit has set, use Bordeaux Mixture, No. 13, for rot, and Paris green for curculio; never spray when trees are in bloom.
3. If signs of rot are present, at the end of a week or ten days repeat the Bordeaux Mixture treatment, No. 13.
4. After fruits are full size, substitute copper sulphate solution, No. 18, for the Bordeaux Mixture.

CURRANT.

(*Worms, Mildew and Four-Lined-Bug.*)

1. As soon as leaves appear, worms are almost certain to be present; spray with Paris green, No. 9.
2. If worms are still present at the end of ten days, repeat Paris green treatment. For mildew use Bordeaux Mixture, No. 13.
3. If worms are persistent, repeat the spray, using White Hellebore, No. 11, instead of Paris green.

A second brood of worms are liable to appear which need as careful treatment as the first.

GOOSEBERRY.

(*Mildew and Worms.*)

1. Worms are as persistent upon the gooseberry as upon the currant, and the same vigilant treatment is necessary. As soon as the leaves appear spray with Paris green; if lice are also present, treat them to kerosene emulsion, No. 1.
2. After a week's time, if the pests are present, repeat the above, and if the mildew has appeared, apply Bordeaux Mixture, No. 13.

3. After fruits are nearly grown, if the conditions favor the development of mildew, substitute sulphide of potassium, No. 16, for the Bordeaux Mixture.

4. If mildew persists after the fruit has been gathered, treat again with the Bordeaux Mixture, No. 13.

GRAPE.

(*Flea beetle, Black-rot, Mildew, Anthracnose.*)

1. A treatment of copper sulphite, No. 17, and another of Paris green, No. 9, should be made before the buds burst.

2. When the leaves have reached a diameter of two inches, make a second application; using Bordeaux Mixture and Paris green, No. 20.

3. As soon as fruits are formed give a third treatment with same ingredients as before. (See second spraying.)

4. After fruits are nearly grown, until they are gathered, all treatment should be made with copper sulphate solution, No. 18, as a substitute for the Bordeaux Mixture.

NURSERY STOCK.

(*Leaf Blight or Twig Blight.*)

1. Begin with Bordeaux Mixture, No. 13, about the time the buds begin to open, and repeat the application as often as necessary to keep the disease in check.

PEACH AND APRICOT.

(*Leaf-curl, Curculio, Mildew, Rot.*)

1. Use copper sulphate, No. 17, on branches before buds burst in the spring.

2. Within a fortnight after the blossoms fall give a thorough application of Bordeaux Mixture with Paris green, No. 20; do *not use London Purple* as a substitute for Paris green on peaches, apricots or plums.

3. Repeat the above if the diseases persist, until fruits are fully grown; if rot yet continues prevalent substitute the Bordeaux Mixture by copper sulphate solution, No. 19. No spraying should be done later than one week before harvesting.

PEAR AND QUINCE.

(*Leaf Blight, Scab, Psylla and Codling Moth.*)

1. In the spring before the buds start, spray with copper sulphate solution, No. 17.

2. Bordeaux Mixture with Paris green, No. 20, should be used

some time during the ten days following the falling of the flowers.

3. In ten or twelve days repeat, (2).

4. Still later (twelve to eighteen days) use Bordeaux Mixture, No. 13.

5. After fruits are grown, if it is thought necessary to use a spray, repeat the Bordeaux Mixture treatment, No. 13.

PLUM.

(Curculio, Black-Knot, Rot.)

1. Black-knots should be carefully cut out and burned during the fall and winter months. The first spraying should be done with the copper sulphate solution, No. 17, before the buds burst.

2. After blossoms have fallen and the fruit has set, spray with Bordeaux Mixture and Paris green, No. 20.

3. About two weeks later repeat, using the same as in the second application.

4. At the end of another fortnight make a fourth spraying, using Bordeaux Mixture, No. 13, only.

POTATO.

(Scab, Blight and Beetles.)

1. For scab use corrosive sublimate treatment, No. 15, soaking the seed for one and one-half hours in a solution made by dissolving 2 oz. corrosive sublimate in 16 gallons of water; or roll the cut tubers in flowers of sulphur.

2. For beetles, spray with Paris green solution, No. 9. This treatment may be combined with the application of Bordeaux Mixture for the blight.

3. Repeat, using both the insecticide and fungicide as long as beetles are troublesome. When the insects have been suppressed, use the Bordeaux Mixture, No. 13, alone, if conditions are favorable for blight.

QUINCE—(see pear.)

RASPBERRY AND BLACKBERRY.

(Rust and Anthracnose.)

1. All badly dieased canes should be cut out and burned.

Before growth starts in the spring, spray the bushes with copper sulphate solution, No. 17.

2. When new canes are twelve to fifteen inches high, spray with Bordeaux Mixture, No. 13.

3. If a third spraying is necessary before crop is gathered, use a dilute copper sulphate solution, No. 18.

4. After the crop has been gathered, all old and diseased canes should be removed; thin the new growth to the desired extent, and then spray with Bordeaux Mixture, No. 13.

STRAWBERRIES.

(Rust.)

1. Just before blossoms open treat with a solution of Paris Green with Bordeaux Mixture, No. 20.

2. After fruits have set, *not while plants are in bloom*, treat with a weak copper sulphate solution, No. 19.

3. If after harvesting it seems desirable to perpetuate the patch, run a mower over it and after the leaves have become sufficiently dry for fire to run, burn it over.

The new growth starting from the roots will be free from blight.

TOMATO.

(Rot and Blight.)

1. After first fruits have set, use Bordeaux Mixture, No. 13, or ammoniacal carbonate of copper, No. 12.

2. If the disease still persists, repeat at short intervals, according as the health of the plants and the state of the weather requires.

How to Spray.

To obtain best results from the use of sprays for preventing injury to our trees and fruits from insects and fungi, it is necessary that the spray be fine, evenly distributed and applied with force. A force pump with a capacity sufficient to give 25 or 30 pounds pressure, with brass cylinder and plunger, will be found to be best and most economical. The brass is not readily acted upon by the chemicals used, and although the first cost of a pump of this class is a little more than that of a cast-iron pump, in the long run, as usual, the best is the cheapest.

The most convenient receptacle for the spraying solution, and the one most easily obtained and mounted is a common oil barrel. Mount this upon a sled, the runners of which are made from plank 2x6 or 8 in. and a little longer than the barrel. The width of the sled should not greatly exceed that of the bulge of the barrel. The beams should be made of 2x6 in. plank and hollowed out to make a saddle to receive the barrel. To make the barrel fast to the sled pass a band of hoop iron over either end and fasten it securely to the runners. When completed we shall have a cask laying horizontally upon a plank sled, to which it is securely fastened. Mount the pump upon the rear end of the barrel, with the handle parallel with the long axis of the barrel. At the front end and on the top side of the barrel remove a portion of one or two of the staves between the second and third hoops leaving an opening 6 in. wide through which the liquid may be poured. To prevent loss of the mixture the opening should be covered with a piece of burlap or oil-cloth. Tack one edge to the barrel having the rest loose to ad-

mit of its being turned back to allow the full opening to be used in filling the barrel.

The length of hose needed will depend upon the character and height of the plants to be sprayed. In general, however, from eight to ten feet will be ample, if the nozzle used is suited to throw a fine spray a long distance. If the nozzle has to be carried into the tree on a pole in order to do the required work, the length of the hose must be increased correspondingly.

The nozzle is the all-important attachment of the spraying apparatus.

A nozzle that will throw a fine spray a long distance, and one that will not clog by any fine particles of lime or dirt which might get into the spraying mixture, is what is wanted. Such a nozzle will facilitate the work of spraying more than most any other invention. Such an one has recently been placed upon the market by the McGowan Co.

For spraying large forest, fruit, or street trees, the barrel, as before described, instead of being mounted upon runners, may be placed upon a wagon. This will be found to be most convenient where the trees are at some distance from each other, or in long rows far enough apart to admit the team and wagon.

Douglas' Special Double-Acting Spraying Pump.

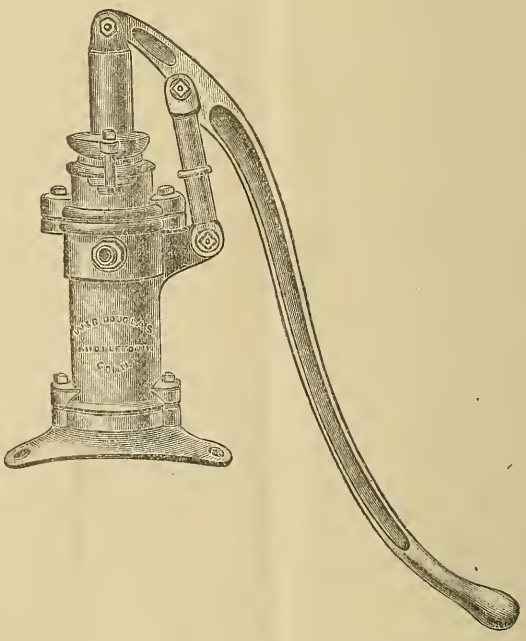

FIGURE 1.

The figure shows a very serviceable style of double acting pump, arranged for either hose or gas pipe discharges, for spraying trees, plants, etc., with chemical solution. It is constructed in a cheap, compact but substantial form, and, being double-acting, throws a very strong spray. Either discharge can be used for a return pipe to the barrel to keep the contents stirred up and prevent settling. It can be attached to a barrel and used same way as pump described on page 238. This pump is made either with iron or brass piston and cylinder. The brass wearing parts, while most expensive, are most durable and will prove cheapest in the end.

Douglas' Emulsion Knapsack Sprayer.

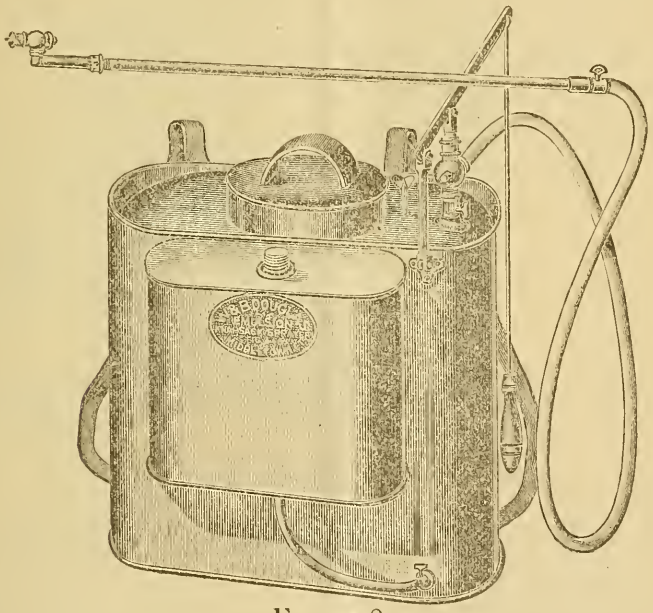

FIGURE 2.

This cut illustrates the latest knapsack device, which has for its object the mechanical mixture of kerosene and water, or any two liquids it may be desirable to use.

The kerosene is placed in the small tank holding 1¼ gallons, which is attached to the main reservoir by two clips at the side, near the top. A quarter inch hose connects the kerosene tank with a brass pipe connecting with the cylinder of the pump just below the brass ball valves. A stop-cock is provided to regulate the flow of kerosene. The flow of water is regulated from the thumb screw at the top of the tank. The kerosene tank is readily detachable from the main reservoir, making sprayer as convenient as the ordinary style, where mixture of liquids is not desired.

Douglas' Perfection Knapsack Spraying Machine.

PUMP ARRANGED WITH ADJUSTABLE FASTENINGS, SO THAT IT CAN BE REMOVED FOR REPAIRS WITHOUT DISTURBING THE TANK.

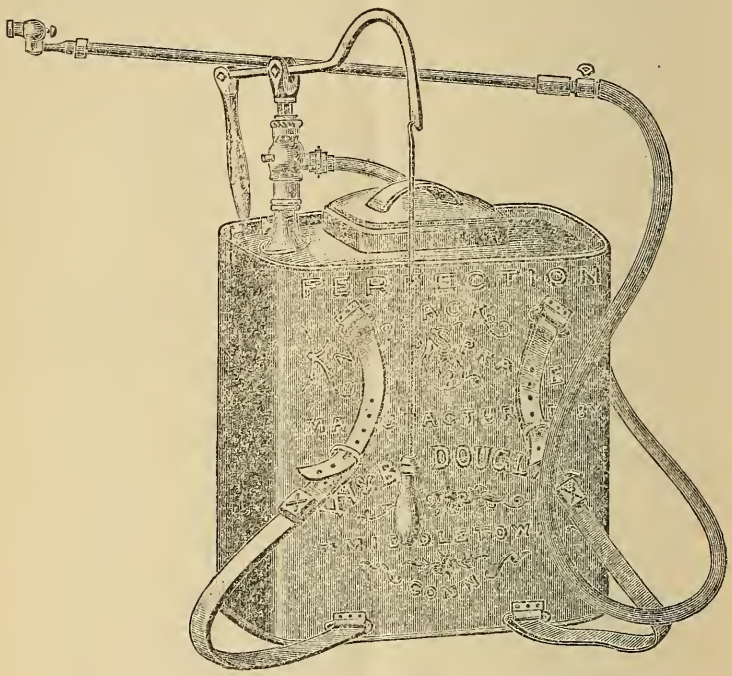

FIGURE 3.

This cut shows the PERFECTION KNAPSACK SPRAYER, which has been improved, in accordance with recommendations made by Prof. B. T. Galloway in the *Journal of Mycology*. The tank is made of either copper or galvanized iron; the discharge is made through hose and a piece of iron pipe with a stop-cock to regulate the stream, the tip being the Pilter-Bourdil or the Vermorel nozzle, either producing the finest spray. It is easily carried on the back, and the Pump operated by a lever, as cut shows. The Pump may be detached for repacking, etc., by simply unscrewing it from the reservoir, which is an important improvement. Since this article was first put upon the market the copper tank has been reinforced at the top, making it extra heavy, thus entirely obviating the danger of bending or tearing the Pump from the copper.

For using Sulphate of Copper and Lime it is necessary to have the copper tank; for Paris Green and London Purple, galvanized iron will answer.

The Aquarius.

FIGURE 4.

"THE AQUARIUS" is very serviceable for throwing a solution of Paris green or London Purple, where only a few plants are to be treated, it is all that would be needed for treating the ordinary kitchen fruit plantation. It is too small for extended work, but is very convenient for washing wagons or windows. It is built strong and durable.

The cylinder, piston-rod and couplings are of brass.

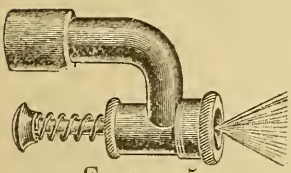

FIGURE 5.

Improved Vermorel Nozzle with Degorger—

IS ARRANGED WITH STUFFING BOX, SO THAT THE LIQUID WILL NOT WET THE OPERATOR WHILE BEING USED.

The principle upon which this nozzle is made has formed the basis of many modifications. All are of value, but none have possessed sufficient merit to displace the Vermorel, where a fine spray thrown a short distance with force, is needed. It is one of the best instruments we have for short distance work and for use with a knapsack pump. For spraying tall trees it is unwieldly, as it must be carried into the top by means of a pole, and then its work is slow, as it covers only a small area. It is an economical device, a feature of great importance in some classes of work.

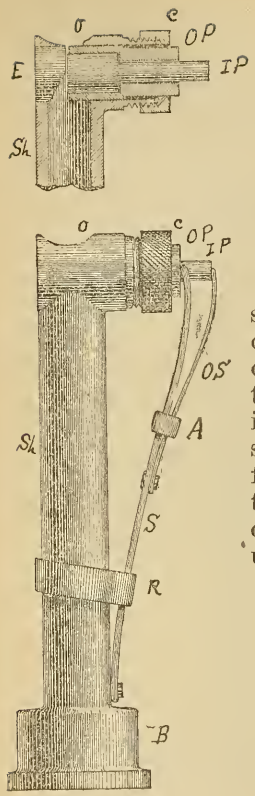

FIGURE 6.

The McGowan Nozzle—

shown in the accompanying cut is the best device yet put upon the market for all classes of work. It is a general purpose nozzle. It throws a fine spray a long distance, adapting it to spraying tall trees; it will throw a fine spray, a mist, a short distance with great force; it is economical in the use of the mixtures, and it is automatic in its action, readily clearing itself if it becomes clogged when using Bordeaux Mixture.

Contact Insecticides.

The following insecticides are those which kill by contact. The essential principle of any mixture of this class must be a volatile oil of considerable penetrating power in order that it shall act upon the body of the insect, or it shall be a heavy substance capable of forming a coating over the body of the insect and thus prevent the power of respiration. In any case the material used, while sufficient to act upon the body of the insect must not be injurious to the delicate tissues of the plant.

1. KEROSENE EMULSION.—Soft soap, 1 quart, or hard soap, ¼ pound; 2 quarts hot water; 1 pint of kerosene. Stir until thoroughly mixed; then dilute with water, using one part of the emulsion to three or four of water. The most satisfactory way of making an emulsion is to use a force pump for mixing; pumping the mixture back into the receptacle several times.

Another method is to use hard soap, ½ pound; boiling water, 1 gallon; kerosene, 2 gallons. Churn or pump the ingredients thoroughly for fifteen minutes. Dilute ten times when using.

2. Kerosene and Milk Emulsion.—Sour milk, 1 gallon; kerosene oil, 2 gallons; warm to blood heat and mix thoroughly. Dilute 10 times with water and use as a dip or spray.

3. Lye Wash.—1 Pound concentrated lye, or potash 1¼ pounds to three gallons water. This may be applied to branches of trees with brush as a remedy for bark lice.

4. Pyrethrum (Buhach). Used dry by dusting upon or beneath the plants. In Alcohol:—Put one part of pyrethrum (buhach) and four parts alcohol, by weight, in any tight vessel. Shake occasionally, and after eight days filter. Apply with an atomizer. Excellent for green-house pests. For some plants it needs to be diluted a little. Another good way is to dissolve about four ounces of powder in 1 gill of alcohol and 12 gallons of water.

5. Quassia.—The following is for plant-lice. Boil 4 ounces quassia chips 10 minutes in a gallon of water; strain off the chips and stir in, as it cools, 4 ounces of soft water. Use syringe or brush in applying and ten or fifteen minutes later give the plant a good syringing with clean water.

6. Soap and Tobacco.—Dissolve 8 pounds of the best soft soap in 12 gallons of rain water, and when cold, add 1 gallon of strong tobacco liquor.

7. Tobacco as Coarse Dust or "Tobacco Fertilizer."— Strewn under melons and squash plants.

8. Tobacco Tea.—Used as a spray for plant lice, is made by steeping stems or leaves in water for a couple of hours.

Poisonous Insecticides.

Insecticides of this class kill by being taken into the system of insects for which they are used. Arsenic and its compounds form the active agent of most of such insecticides.

9. Paris Green.—As a spray use 1 pound to 200 gallons of water. Keep well stirred so that the poison shall be held in suspension. If this is neglected the green will settle to the bottom of the vessel, as it is not soluble in water, and the result will be that the spray will contain little poison at first and too much towards the last. In spraying stone fruits use the mixture more dilute. 1 pound of poison to 300 gallons of water.

10. London Purple.—This poison should be used same as Paris green. 1 pound to 200 gallons of water. It should never be used upon peach trees, because the foliage is very susceptible to injury from the arsenites.

11. White hellebore—Used as a spray. 1 ounce of the poison to 3 gallons of water. When applied dry it is seldom mixed with anything. A little flour, however, makes it more adhesive.

Fungicides.

At the present time the use of fungicides is quite as important as the use of insecticides in the culture of fruits and vegetables.

12. Ammonical Carbonate of Copper.—The stock solution is

made by adding 5 ounces of carbonate of copper, to 3 pints of ammonia (26°), this may be kept any length of time in a bottle with a glass stopper. For use dilute with 45 gallons of water.

13. Bordeaux Mixture.—Dissolve 6 pounds of copper sulphate in a wooden or earthen vessel. In another tub or vessel slake 4 pounds of *fresh* lime; add enough water to reduce it to the consistency of a thick whitewash. Pour this slowly into the vessel containing the copper sulphate solution, using a coarse gunny sack stretched across the top of the vessel for a strainer. Dilute to 45 gallons before applying to plants of any kind.

14. Modified eau celeste.—Dissolve 4 pounds of copper sulphate in 10 gallons of water, and stir in 5 pounds of sal soda; then add three pints, of strong aqua ammonia; dilute to 45 gallons.

15. Mercuric Chloride (corrosive sublimate) made by "dissolving 2 ounces of the chloride in 2 gallons of water and letting it stand several hours, or over night, and diluted to 16 gallons." Corrosive sublimate is very poisonous and should be used with caution. In preparing and applying the mixture always use a wooden or earthen vessel.

16. Potassium Sulphide.—Dissolve 3 ounces of potassium sulphide (liver of sulphur) in 10 gallons of water.

17. Copper Sulphate Solution.—(Standard solution.) Dissolve 1 pound of copper sulphate in 25 gallons of water.

This solution is too strong to be used upon the leaves of plants, and should only be applied to the branches before buds start in the spring

18. Dilute Copper Sulphate Solution.—One pound of copper sulphate dissolved in 250 gallons of water.

19. Very Dilute Copper Sulphate Solution.—Made by dissolving one pound of copper sulphate in 500 gallons of water.

These weak solutions are only to be used in case of necessity late in the season when a treatment with Bordeaux Mixture would leave the fruits discolored and spotted at marketing time. No. 18 is safely used on nearly all plants except peaches, plums and beans, where No. 19 should be used instead.

20. Combination of Insecticide and Fungicide.—The only safe combination of this character, is that of Bordeaux mixture with Paris green or London purple. The combination of these mixtures results in no injury to the foliage of the plants treated, and yet each retains its value to the extent of being as good as when used separately. The great value of the combination is in lessening the cost of treatment, for we save the cost of one application. In preparing the mixture use the formula for Bordeaux mixture given under No. 13 and add to it Paris green or London purple at the rate of 1 pound to each 200 gallons of the mixture. While using keep the mixture well stirred.